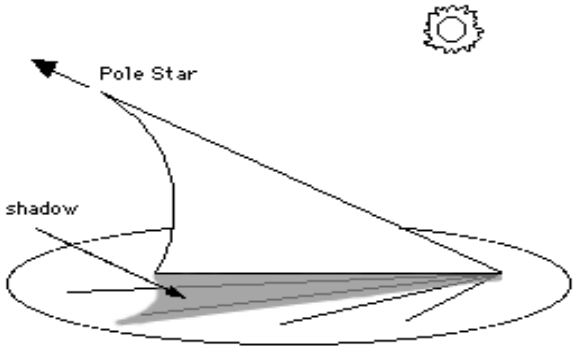
# CHAPTER 4


# Forms of Energy



# Physical Science Vocabulary

Vocabulary for Chapter 4

| No.# | Term | Page # | Definition |
|---|---|---|---|
| | Mechanical Energy | | |
| | Elastic Potential Energy | | |
| | Joule | | |
| | Potential Energy | | |
| | Kinetic Energy Formula | | |
| | Law of Conservation of energy | | |
| | Chemical Potential Energy | | |
| | Gravitational Potential Energy | | |
| | Kinetic Energy | | |
| | Law of Conservation of Energy | | |
| | Nuclear Fusion | | |
| | Energy | | |
| | Electrical Energy | | |
| | Nuclear Energy | | |
| | Nuclear Fission | | |

**Impulse** is defined as the integral of a force acting on an object, with respect to time. This means that impulse contains the product of force and time.

- Impulse changes the momentum of an object. As a result, a large force applied for a short period of time can produce the same momentum change as a small force applied for a long period of time.
- An impulse can act on an object to change either its linear momentum, angular momentum, or both.

**IMPULSE = (FORCE) X (TIME)**

$$F = m.a$$

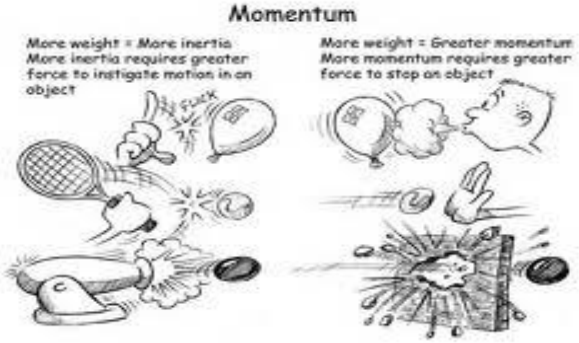
$$F = m.\frac{\text{Change in Velocity}}{\text{time interval}}$$

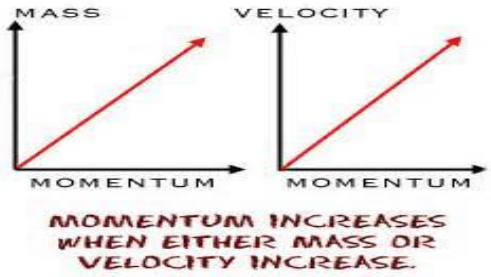
$$F.\Delta t = m.\Delta V$$

impulse change in momentum

**Momentum** is connected to force by impulse, which is simply if the force has a constant magnitude during its action. If the force changes with time, then one must integrate to find the impulse:

- Momentum is a vector. This means it has direction and magnitude. Momentum's magnitude is calculated by the formula p=mv.
- The Momentum-Impulse Theorem states that the change in momentum of an object is equal to the impulse exerted on it: (change in momentum) = (impulse)

# Impulse Practice Problems


$F = m.a$

$F = m.\frac{\text{Change in Velocity}}{\text{time interval}}$

$F.\Delta t = m.\Delta V$

impulse — change in momentum

$$\text{Impulse} = \text{Force} \times \text{time} = \vec{F}\Delta t$$

$$\Delta t = t_{final} - t_{initial}$$

## Impulse & Momentum Worksheets

**A**


$M_R$= 60 kg

$M_B$= 20 kg

Impulse: ___
Momentum c
Momentum o

**B**


**C**

BEFORE

$V_o$ = 20 m/s
m = 0.150 kg

AFTER

V = 35 m/s
Line drive –
straight back at
the pitcher.

**D**

$V_o$ = 10 m/s
m = 0.1 kg

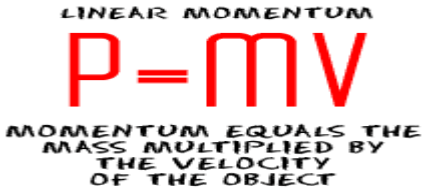
The snow ballhi
Susie on the hea
and sticks there

Impulse

$\overrightarrow{\text{Impulse}} = \sum \vec{F}\Delta t$ [N][s]

net force — elapsed time

# Momentum Practice Problems


1. What is the momentum of a 70 kg runner traveling at 10 m/s?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

2. What is the momentum of an 800 kg car traveling at 20 m/s?

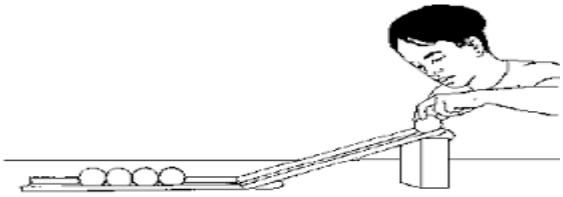
| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

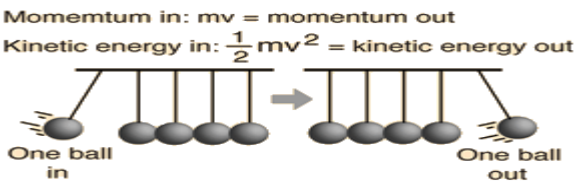
3. What is the momentum of a 47 gram tennis ball that is traveling at 40 m/s?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

4. What is the momentum of a 120 pound bicyclist that is traveling at 25 mph?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |





# Momentum

***Granny whizzes around the rink and is suddenly confronted with Ambrose at rest directly in her path. Rather than knock him over, she picks him up and continues in motion without "braking."***
***Consider Granny and Ambrose as two parts of one system. Since no outside forces act on the system, the momentum of the system before the collision equals the momentum of the system after the collision.***

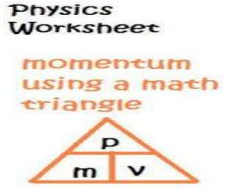
| Before Collision | |
|---|---|
| Granny's Mass | 80 kg |
| Granny's Speed | 3 m/s |
| Granny's Momentum | |
| Ambrose's Mass | 40 kg |
| Ambrose's Speed | 0 m/s |
| Ambrose Momentum | |
| Total Momentum | |

1. After the collision, does Granny's speed increase or decrease? _____

2. After the collision, does Ambrose's speed increase or decrease? _____

3. After the collision, what is the total mass of Granny + Ambrose? _____

4. After the collision, what is the total momentum of Granny + Ambrose? _____



# Worksheet on different types of energy

Each type of energy has its advantages and disadvantages.
Research each source and complete the table below.

| Energy source | Source always available | Good points | Bad points | When/where is the soure worth exploiting? |
|---|---|---|---|---|
| Solar | | | | |
| Wind | | | | |
| Wave | | | | |
| Biomass | | | | |
| Geothermal | | | | |
| Hydropower | | | | |
| Tides | | | | |
| Coal | | | | |
| Oil | | | | |
| Natural gas | | | | |
| Nuclear power | | | | |

# Forms of Energy

All forms of energy fall under two categories:

## POTENTIAL

Potential energy is stored energy and the energy of position (gravitational).

**CHEMICAL ENERGY** is the energy stored in the bonds of atoms and molecules. Biomass, petroleum, natural gas, propane and coal are examples.

**STORED MECHANICAL ENERGY** is energy stored in objects by the application of force. Compressed springs and stretched rubber bands are examples.

**NUCLEAR ENERGY** is the energy stored in the nucleus of an atom—the energy that holds the nucleus together. The nucleus of a uranium atom is an example.

**GRAVITATIONAL ENERGY** is the energy of place or position. Water in a reservoir behind a hydropower dam is an example.

## KINETIC

Kinetic energy is motion. It is the motion of waves, electrons, atoms, molecules and substances.

**ELECTRICAL ENERGY** is the movement of electrons. Lightning and electricity are examples.

**RADIANT ENERGY** is electromagnetic energy that travels in transverse waves. Solar energy is an example.

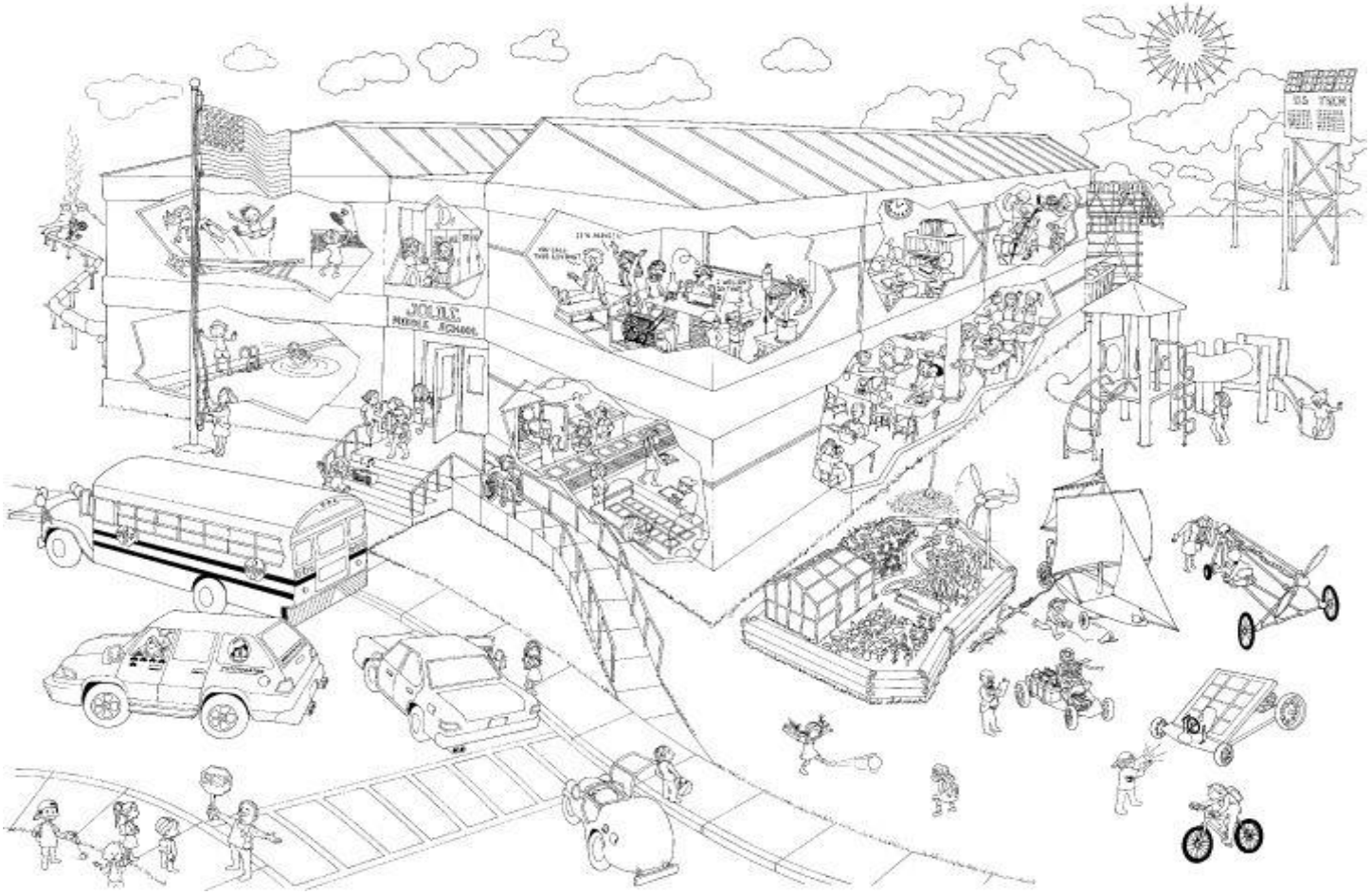
**THERMAL ENERGY** or heat is the internal energy in substances—the vibration or movement of atoms and molecules in substances. Geothermal is an example.

**MOTION** is the movement of a substance from one place to another. Wind and hydropower are examples.

**SOUND** is the movement of energy through substances in longitudinal waves.

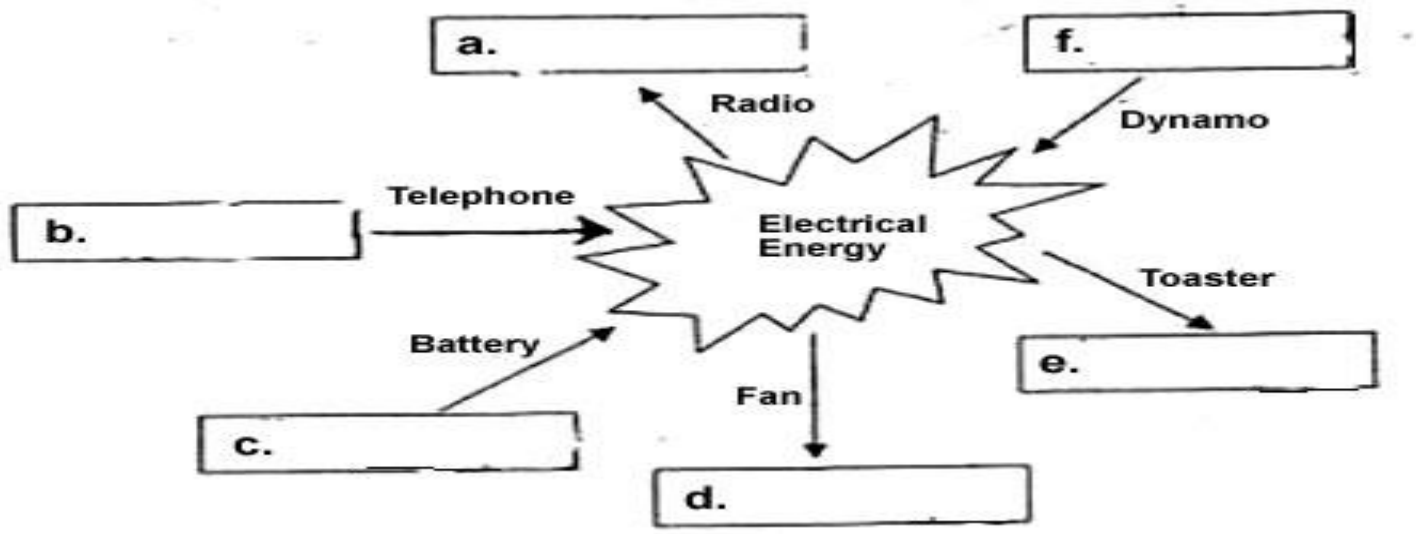
**Forms of Energy I**

**Directions**: Identify types of Energy forms in the picture below.



**Forms of Energy II**

**Directions**: List the *7 Forms* of Energy.




**Identify the form of Energy**

**Directions**: Identify each type of Energy in the chart below.

Energy Transformation Game

| | | | | | | |
|---|---|---|---|---|---|---|
| Sun  | Windmill  | Microwave  | Solar Calculator  | Crane  | Satellite Dish  | Siren  |
| Tanning Bed  | Nuclear Power Plant  | Hot-air Balloon  | Magnifying Glass  | Candle  | Electric Guitar  | Firecracker  |
| Battery  | Piano  | Light Bulb  | Mixer  | Iron  | Lightstick  | Bicycle  |
| Television  | Person Eating  | Plant  | | | | |

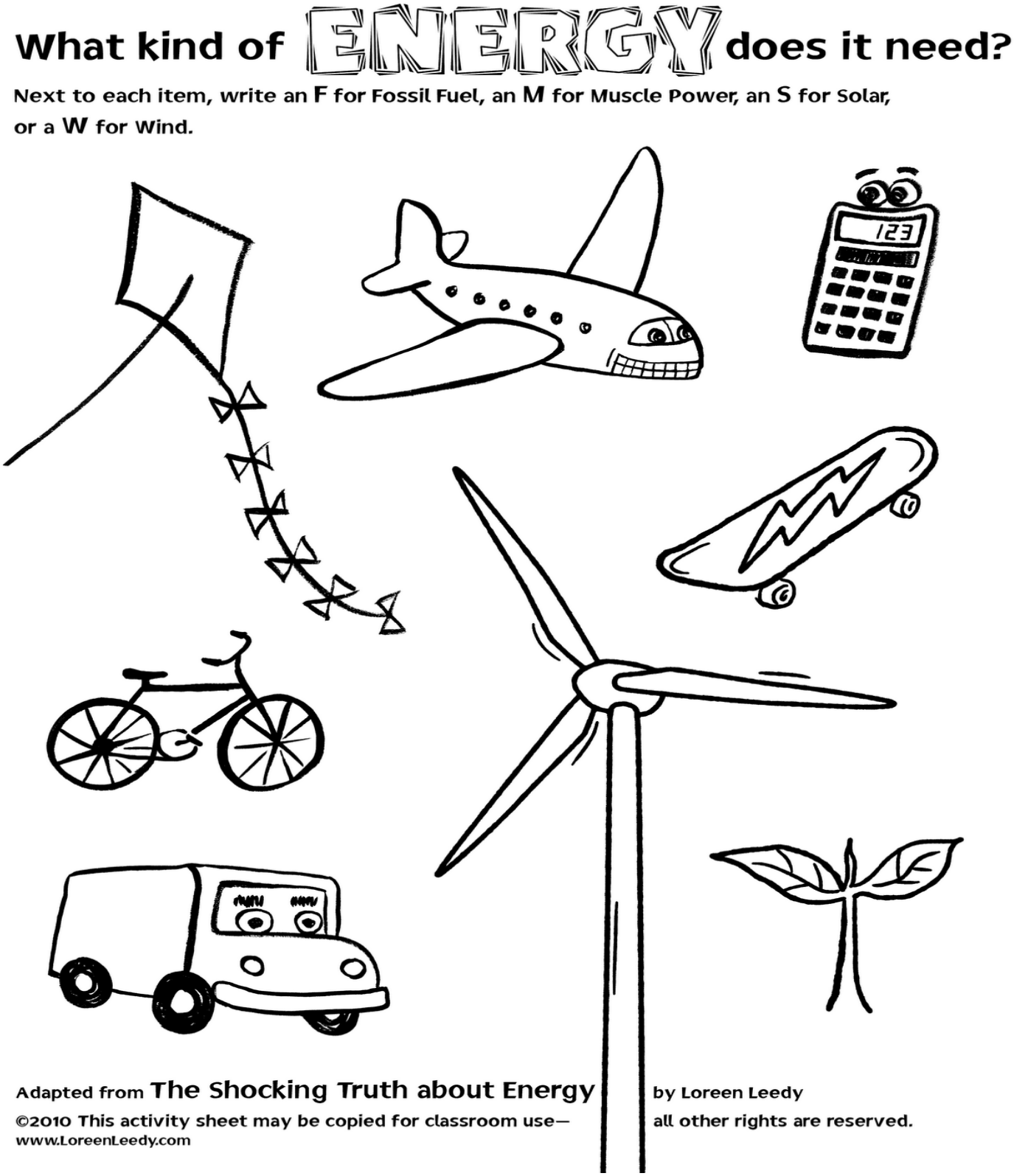
Em = Electromagnetic
T = Thermal

E = Electrical
C = Chemical
N = Nuclear

Mp = Mechanical (potential)
Mk = Mechanical (kinetic

**Identify the Form of Energy III**

**Directions**: Identify each type of Energy in the chart below.

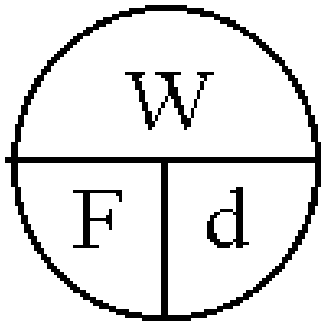


## Work and Power Definitions

**Work**: is the product of a force exerted on an object multiplied by the object's displacement.

- **Work** can be defined as transfer of energy.
- **Work** is done on an object when you transfer energy to that object. If one object transfers (gives) energy to a second object, then the first object does work on the second object.
- **Work** is the application of a force over a distance.
- **Work** is the force is equal to the weight of the object, and the distance is equal to the height of the shelf (W= Fxd).

### Work Formula




**Power** – is the rate at which is done.

- Power is the work done in a unit of time. In other words, power is a measure of how quickly work can be done.
- The unit of power is the Watt = 1 Joule/ 1 second.
- One common unit of energy is the kilowatt-hour (kWh).
- POWER (P) is the rate of energy generation (or absorption) over time: P = E/t
- Power's SI unit of measurement is the Watt, representing the generation or absorption of energy at the rate of 1 Joule/sec.

### Power Formula

$$\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{\text{Force} \cdot \text{Displacement}}{\text{Time}}$$

$$\text{Power} = \text{Force} \cdot \frac{\text{Displacement}}{\text{Time}}$$

$$\boxed{\text{Power} = \text{Force} \cdot \text{Velocity}}$$


**P, Power**
Measured in watts W
Is the amount of work done

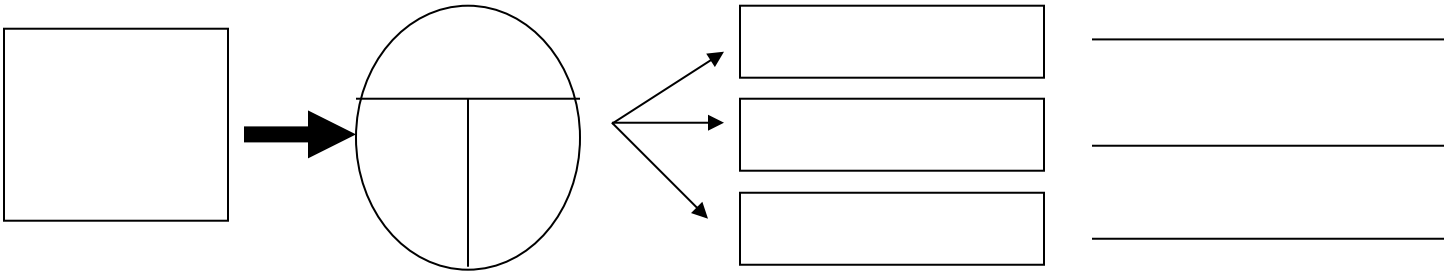
**I, Current**
Measured in amps A
Is rate of flow of charge

**V, Voltage**
Measured in volts V
Difference of electric potential

# WORK PROBLEMS I

**Calculating Work**: Work has a special meaning in science. It is the product of the force applied to an object and the distance the object moves. The unit of work is the Joule (J).

**Formula** **Manipulations** **Solve For** **Units**



1. A book weighing 1.0 Newton is lifted 2 meters. How much work was done?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

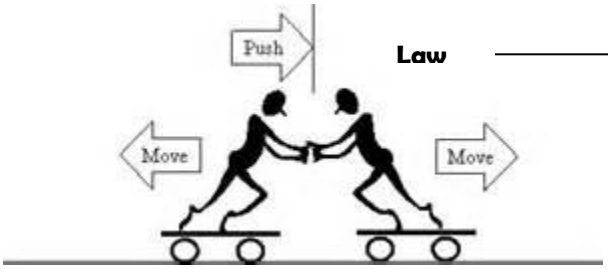
2. A force of 15 Newton's is used to push a box along the floor a distance of 3 meters. How much work was done?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

3. It took 50 joules to push a chair 5 meters across the floor. With what force was the chair pushed?

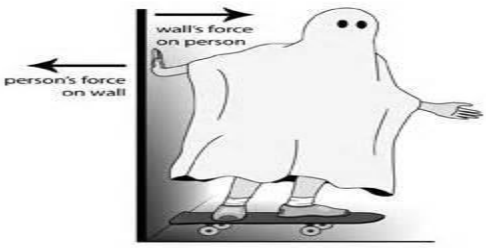
| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

**Which of Newton's Law explains the pictures below?**




**Law** _____

**Law** _____



# WORK PROBLEMS I

4. A force of 100 Newton's was necessary to lift a rock. A total of 150 joules of work was done? How far was the rock lifted?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

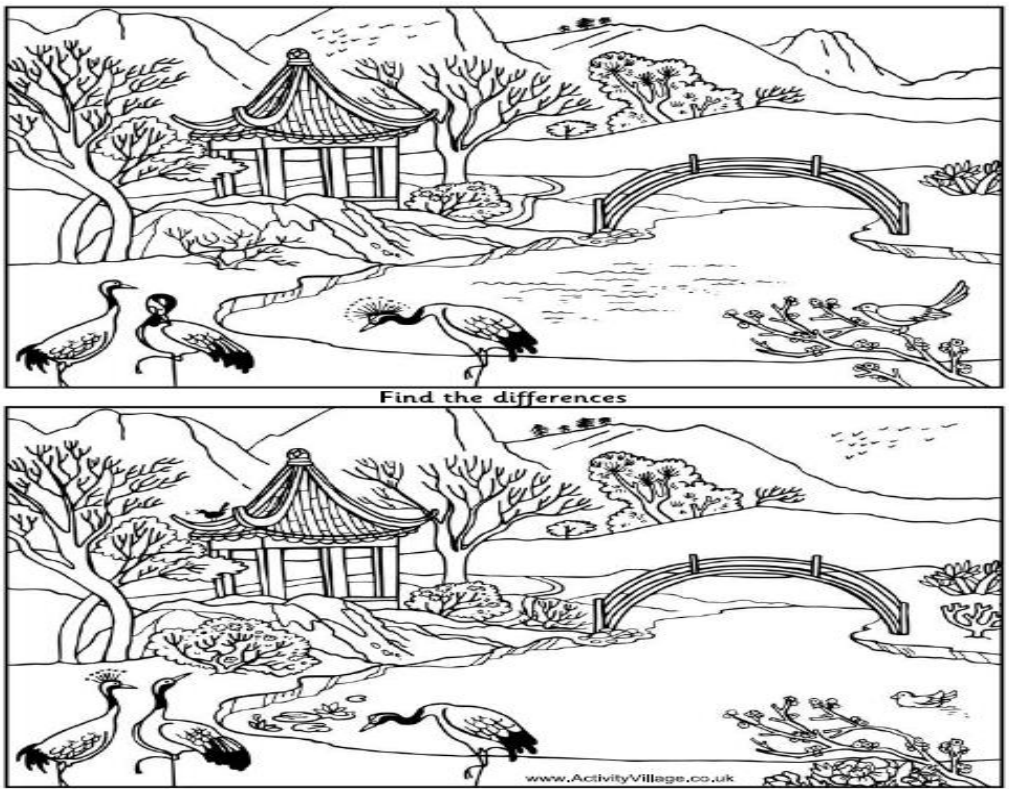
5. It took 500 Newton's of force to push a car 4 meters. How much work was done?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

6. A young man exerted a force of 9,000 Newton's on a stalled car but was unable to move it. How much work was done?

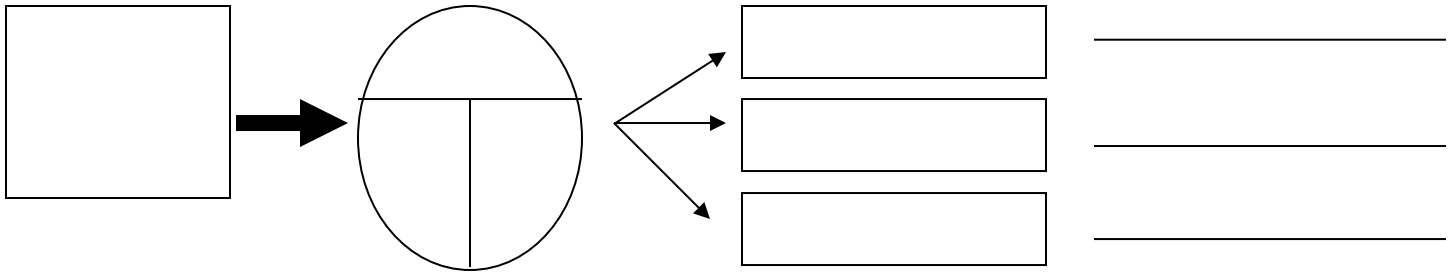
| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

**Find The Differences?**



# WORK PROBLEMS II

**Formula** **Manipulations** **Solve For:**



7. A rock weighing 2 Newton's was lifted 3 meters. How much work was done?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

8. A rock weighing 6.5 Newton's was moved 2 meters. How much work was done?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

9. It took 600 Newton's of force to move a car 4 meters. How much work was done?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

10. It took 45 Newton's to lift a crate 1.5 meters. How much work was done?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

**What is this method called?**

_____

_____

# WORK PROBLEMS II

11. A box weighing 3.2 Newton's was moved 2.5 meters. How much work was done?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

12. A box weighing 6.4 Newton's was moved 2.5 meters. How much work was done?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

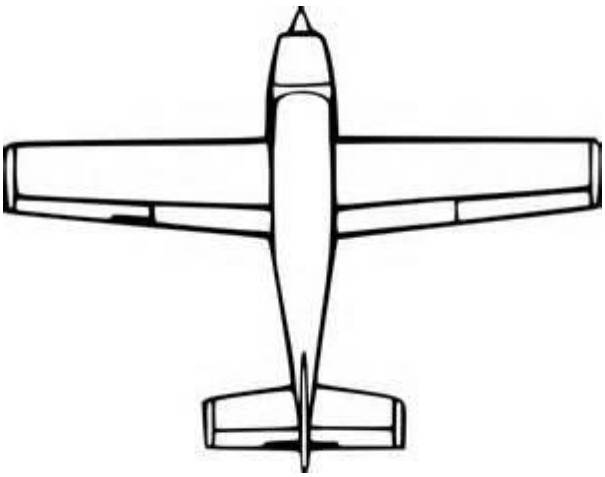
13. 45 joules were expended to move a box weighing 30 Newton's. How many meters was it moved?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | ……..,;,m<br>m |

14. It took 50 joules to push a crate 2.5 meters. With what force was the crate pushed?

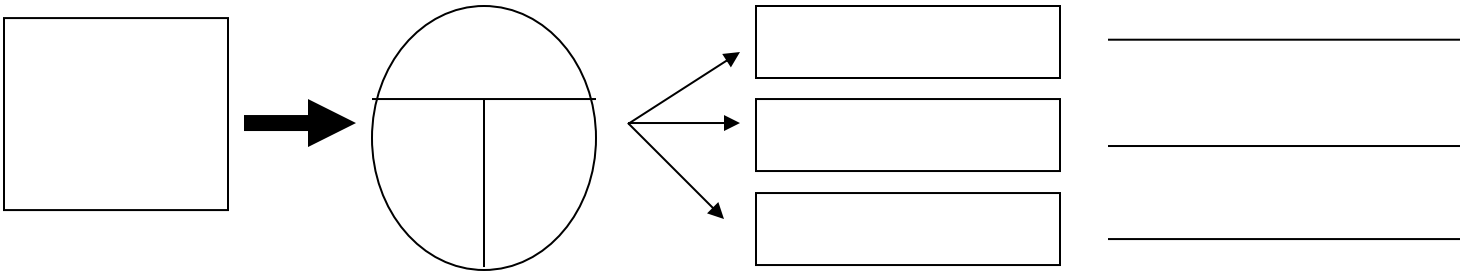
| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

**Compare & Contrast the methods of flight.**



# WORK AND POWER PROBLEMS I

**Formula** **Manipulations** **Solve For:**



1. A box weighing 25 N is lifted 5.0 meters. Calculate the work done?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

2. A force of 2000 N is needed to lift a refrigerator. If the work done is 800 joules, how high was the refrigerator lifted?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

3. At least 2,500 Joules of work is needed to push a lawnmower for 100 meters. How much force was needed?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

4. Lifting a book 0.50 meters off your desk requires 15.0 Newton's. How much work is done?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

**Which forces are acting on this weight lifter?**

# WORK AND POWER PROBLEMS I

5. While rowing in a race, John uses his arms to exert a force of 165 N per stroke while pulling the oar 0.80 meters. How much work does he do in 30 strokes?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

6. Dragging a suitcase for 25 meters requires 3,600 Joules of work. How much force was exerted on the suitcase?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

7. Anna walks up the stairs on her way to class. She weighs 565 Newton's and the stairs go up 3.25 meters vertically. What is her power if she climbs the stairs in 12.6 seconds?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

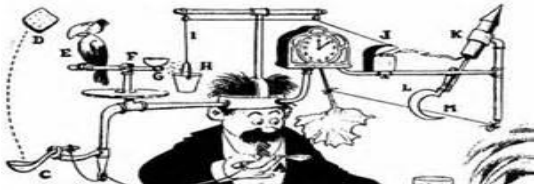
8. What is the power if 250 J of work is done in 100 seconds?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

9. How much time does it take for 30 Joules of work to be done by 2.0 Watts of power?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

10. A mechanic's power output is 107 Watts when he uses a jack to lift a car in 5.0 seconds. What is the amount of work done on the car?



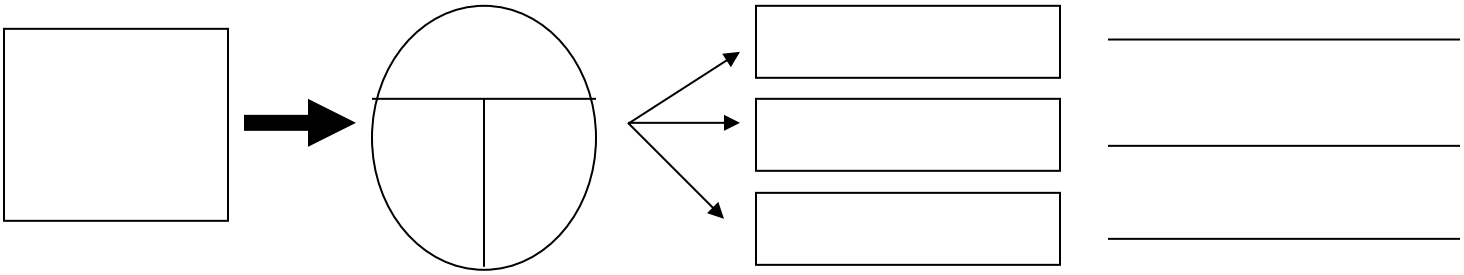
What type of machines is this called?

_____

# CALCULATING POWER I

**Formula**

**Manipulations** **Solve For:**



1. A set of pulleys is used to lift a piano weighing 1, 000 Newton's. The piano is lifted 3 meters in 60 seconds. How much power is used?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

2. How much power is used if a force of 35 Newton's is used to push a box a distance of 10 meters in 5 seconds?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

3. What is the power of a kitchen blender if it can perform 3,750 joules of work in 15 seconds?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

4. How much work is done using a 500-watt microwave oven in 5 minutes?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

# CALCULATING POWER I

5. How much work is done using a 60-watt light bulb for 1 hour?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

6. How much power is needed to lift a 200 Newton object to a height of 4 meters in 4 seconds?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

7. What is the power output of an engine that does 60,000 Joules of work in 10 seconds?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

8. How much power is needed to lift an object that weighs 200 N to a height of 4 meters in 12 seconds?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

**Directions**: Write the letter that best answers the question or completes the statement on the line.

_____ 1. In which of the following is no work done:

(a) Climbing stairs, (b) Lifting a book, (c) Pushing a cart (d) None of the above

_____ 2. If you exert a force of 10.0 N to lift a box a distance of 0.75 meters, how much work do you do?

(a) 0.075 J, (b) 7.5 J, (c) 10.75 J, (d) 75 J

_____ 3. If you perform 30 joules of work lifting a 20-N box from the floor to a shelf, how high is the shelf?

(a) 0.5 meters, (b) 1.5 meters, (c) 0.6 meters, (d) 2 meters

_____ 4. If you exert a force of 500 N to walk 4 meters up a flight of stairs in 4 seconds, how much power do you use?

(a) 31 Watts, (b) 500 Watts, (c) 2,000 Watts, (d) 8,000 Watts,

_____ 5. What is the unit of work?

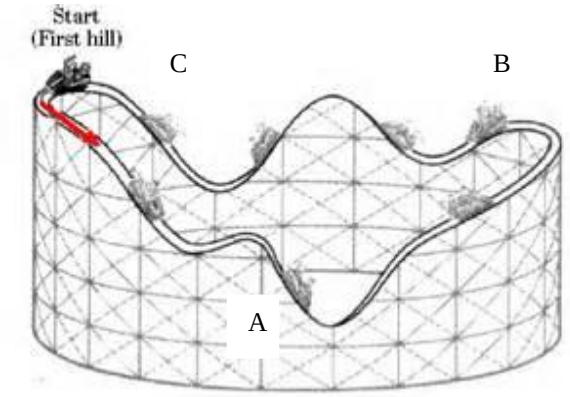
(a) joule, (b) watt. (c) Newton / meter (d) all of the above

_____ 6. Calculate the force a person exerts in pulling a wagon 20 meters if 1,500 joules of work are done?

(a) 7.5 Newton's, (b) 30,000 Newton's, (c) 0.75 Newton's, (d) 75 Newton's

**Potential & Kinetic Energy Worksheet**

**Directions**: Identify all the Maximum and Minimum Potential Energy & Kinetic Energy regions.



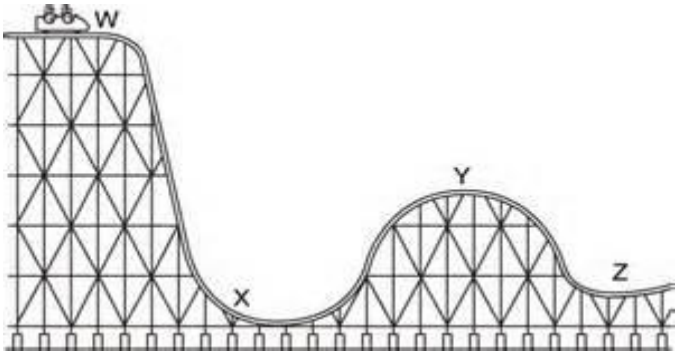

**Roller Coaster**

Minimum PE _____

Maximum PE _____

Minimum KE _____

Maximum KE _____



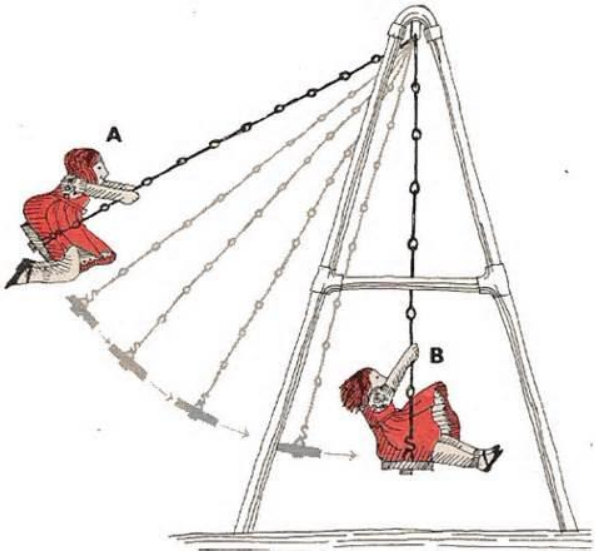

**Roller Coaster**

Minimum PE _____

Maximum PE _____

Minimum KE _____

Maximum KE _____



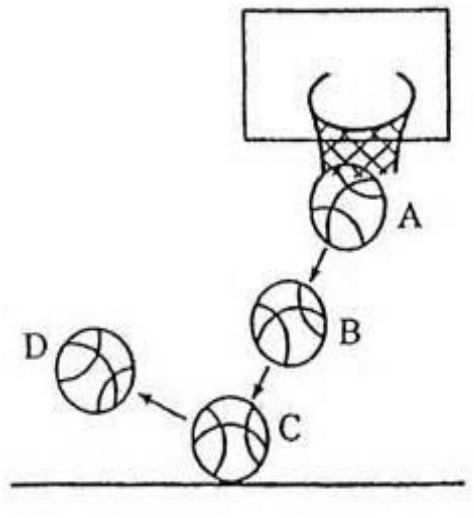

**Playground Swing**

Minimum PE _____

Maximum PE _____

Minimum KE _____

Maximum KE _____




**Basketball**

Minimum PE _____

Maximum PE _____

Minimum KE _____

Maximum KE _____

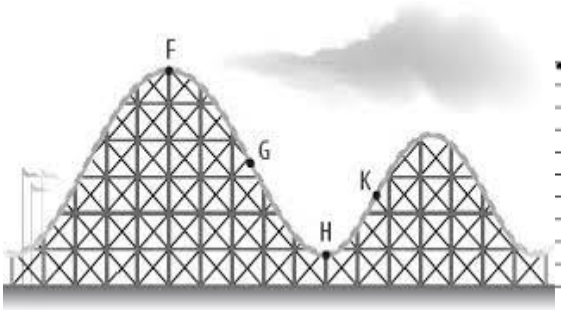
**What thype of energy is being used in this picture?**

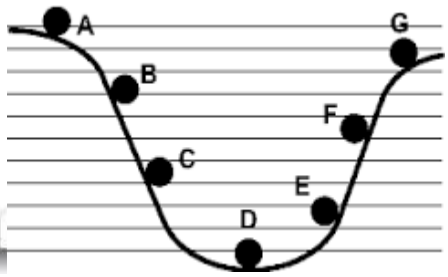
_____

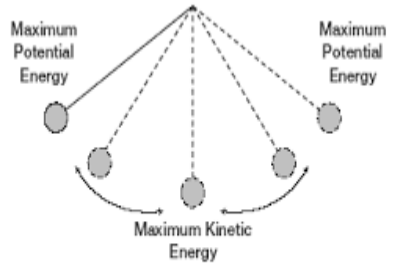
_____

**Supplementary Insert**

**POTENTIAL & KINETIC ENERGY**




The change of potential energy into kinetic energy, and kinetic energy into potential energy, in a pendulum.

Before You Read

NAME: _____

# How Energy Moves and Changes Form

1. **Put a check mark (✓) next to the answer that is most correct.**

   a) **Green plants transform light energy into**
   - ○ A solar energy
   - ○ B kinetic energy
   - ○ C chemical energy
   - ○ D electrical energy

   b) **Which kind of energy is carried through wires?**
   - ○ A chemical
   - ○ B electrical
   - ○ C nuclear
   - ○ D solar

   c) **What is true of all energy changes?**
   - ○ A Energy always increases.
   - ○ B Some energy is always destroyed.
   - ○ C The total amount of energy does not change.
   - ○ D Some energy is always changed into chemical energy.

2. **Circle T if the statement is TRUE or F if it is FALSE.**

| | | | |
|---|---|---|---|
| T | F | a) | Transfer means "move." |
| T | F | b) | Transform means "change." |
| T | F | c) | Waves transfer matter but not energy. |
| T | F | d) | During a roller coaster ride, many transformations between kinetic and potential energy happen. |
| T | F | e) | Most forms of energy can be transferred. |

**FREE FALL**

Name Period Date

## Concept-Development Practice Page 2-2

### *Free Fall Speed*

1. Aunt Minnie gives you \$10 per second for 4 seconds. How much money do you have after 4 seconds? _____

2. A ball dropped from rest picks up speed at 10 m/s per second. After it falls for 4 seconds, how fast is it going? _____

3. You have \$20, and Uncle Harry gives you \$10 each second for 3 seconds. How much money do you have after 3 seconds? _____

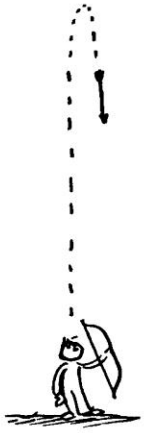
4. A ball is thrown straight down with an initial speed of 20 m/s. After 3 seconds, how fast is it going? _____

5. You have \$50 and you pay Aunt Minnie \$10/second. When will your money run out? _____

6. You shoot an arrow straight up at 50 m/s. When will it run out of speed? _____

7. So what will be the arrow's speed 5 seconds after you shoot it? _____

8. What will its speed be 6 seconds after you shoot it? 7 seconds? _____ _____



### *Free Fall Distance*

1. Speed is one thing; distance another. *Where* is the arrow you shoot up at 50 m/s when it runs out of speed? _____

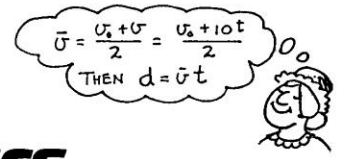
2. How high will the arrow be 7 seconds after being shot up at 50 m/s? _____

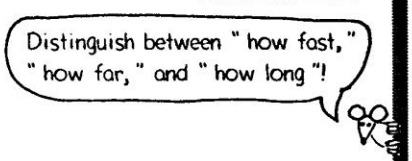
3 a. Aunt Minnie drops a penny into a wishing well and and it falls for 3 seconds before hitting the water. How fast is it going when it hits? _____

b. What is the penny's average speed during its 3-second drop? _____

c. How far down is the water surface? _____


4. Aunt Minnie didn't get her wish, so she goes to a deeper wishing well and throws a penny straight down into it at 10 m/s. How far does this penny go in 3 seconds? _____




Conceptual PHYSICS

## Practice Test: - Chapter 4

### Section 1: True / False

*Indicate whether the sentence or statement is true (*T*) of false (*F*).*

1. _____ Energy doesn't have to involve motion.
2. _____ Energy is the ability to cause a change.
3. _____ Energy is measured in joules.
4. _____ Energy in the form of motion is potential energy.
5. _____ A rock at the edge of a cliff has kinetic energy because of its position.
6. _____ When you ride a playground swing, your potential energy is the greatest at the highest point.
7. _____ Lowering an object decreases its potential energy.
8. _____ Conduction is the transfer of energy by the bulk movement of matter.
9. _____ Radiation is the transfer of energy in the form of particles.
10. _____ Solar energy can be changed into thermal energy without any work being done.

### Section 2: Modified True / False

Indicate whether the sentence is true of false. If false, change the *identified word* or *phrase* to make the sentence or statement true.

11. _____ *Thermal* energy is energy stored in things that stretch or compress. _____
12. _____ A toaster uses *chemical energy* to make toast. _____
13. _____ Doubling an object's *velocity* will double its kinetic energy. _____

### Section 3: Multiple Choices

*Identify the letter of the choice that completes the statement or answers the question.*

14. _____ The kinetic energy of an object increases as its _____ increases.

a. Gravitational energy
b. Potential energy
c. specific heat
d. velocity

15. _____ Increasing the sped of an object _____ its potential energy.

a. Does not affect
b. Increases
c. decreases
d. changes

16. _____ The SI unit for energy is the _____.

a. Calorie
b. Joule
c. meter per second
d. kilogram

17. _____ Which of the following devices does not make use of electrical energy _____.

a. Upright piano
b. Radio
c. toaster
d. digital camera

**Practice Test: - Chapter 4**

18. _____In a nuclear fusion reaction, mass is transformed into _____.

a. Matter
b. Nuclei
c. energy
d. light

19. _____ According to the law of conservation of energy, the total amount of energy in the universe, _____.

a. Remains constant
b. changes constantly
c. increases
d. decreases

20. _____ The rate at which work is done is called _____.

a. Efficiency
b. Effort force
c. force
d. power

21. _____ The unit of power is the _____.

a. Joule
b. Watt
c. m/s
d. second

22. _____ All of the following are good conductors of heat EXCEPT _____.

a. Air
b. Aluminum
c. copper
d. silver

23. _____ Solar collectors are part of a (n) _____.

a. Active solar heating system
b. External combustion engine
c. radiant heating system
d. passive solar heating system

24. _____ The process by which engine fuels burn is called _____.

a. Combustion
b. Condensation
c. conduction
d. convection

25. _____ Which of the following would be the best insulator? _____.

a. Air
b. Aluminum
c. copper
d. silver

26. _____ Through which of the following will convection most likely occur? _____.

a. Liquids & gases
b. Solids & liquids
c. solids
d. solids & gases

27. _____ The transfer of energy that does NOT require mater is _____.

a. Combustion
b. Radiation
c. conduction
d. convection

**Practice Test: - Chapter 4**

**Section 4: Completion - *Complete the sentence.***

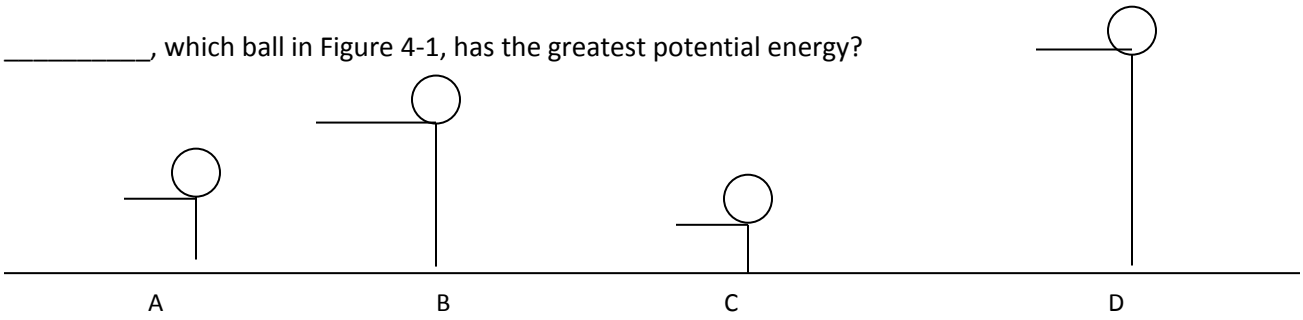
28. Stored energy is called _____ energy.

29. Work, like energy, is measured in _____.

30. When you move your hand or foot, your body has converted potential energy into _____ energy.

**Section 5: Short Answer**

31. _____, which ball in Figure 4-1, has the greatest potential energy?




32. _____, which ball in Figure 4-1, has the least potential energy?

**Section 6: Problems**

*Show all of your work to receive complete credit. Round off answers to 2 decimal places. Write down units.*

## Work = Force / Distance

33. A person expended 500N to move a full wheelbarrow 30 meters. How much work was done?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

34. Dragging a suitcase for 25 meters requires 3600 Joules of work. How much force was exerted on the suitcase?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

**Which can exert more force?**

1. _____
2. _____

**Practice Test: - Chapter 4**

**Power = Work / time**

35. A crane lifts a 35,000-N steel girder a distance of 25meters in 45 seconds. How much power did the crane require to lift the girder?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

**GPE = mgh**

36. What is the gravitational potential energy of a ceiling fan that has a mass of 75kg and is 4 meters above the ground?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

**KE = ½mv$^2$**

37. A jogger whose mass is 60kg is running at a speed of 3 m/s. What is the jogger's kinetic energy?

| Formula | Set Up & Solve | Answer |
|---|---|---|
| | | |

**Explain the centrifugal forces in the picture below?**